MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

DET5028 – INDUSTRIAL ELECTRONICS

(Diploma in Electronic Engineering)

6 MARCH 2020
9.00 a.m. - 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 6 pages excluding the cover page with 5 Questions only.

2. Attempt **ALL FIVE** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1 (20 Marks)

a) Design a PLC ladder diagram for a motor controlled by START push button and STOP push button. An indicator lamp 1 must be illuminated when the power is applied to the motor and another indicator lamp 2 must be illuminated when the power is not applied. Use the following I/O assignment in the PLC ladder diagram. [8 Marks]

I/O Assignment Table-1Q(a)

X400	START PB
X401	STOP PB
Y430	MOTOR
Y431	INDICATOR LAMP 1
Y432	INDICATOR LAMP 2

b) Draw a PLC ladder diagram that is equivalent to the digital logic diagram shown in Figure-1Q(b). [8 Marks]

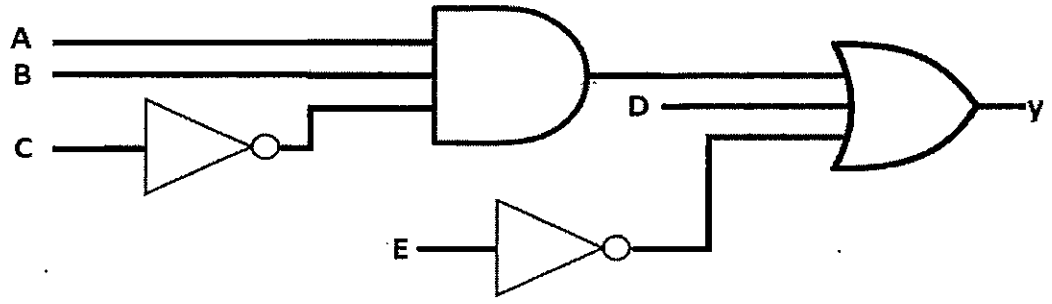

Figure-1Q(b)

i. Write the Boolean expression for the logic diagram shown in Figure-1Q(b). [4 Marks]

Continued ...

Question 2 (20 Marks)

(a) Refer to the relaxation oscillator shown in Figure-2Q(a). The following values are given:

$V_{DC} = 12V$, $R = 60k\Omega$, $R_1 = 0.2k\Omega$, $C = 0.1pF$, $r_{BB} = 6k\Omega$, $\eta = 0.6$, $V_V = 1.5V$, $I_V = 8mA$ and $I_P = 8\mu A$.

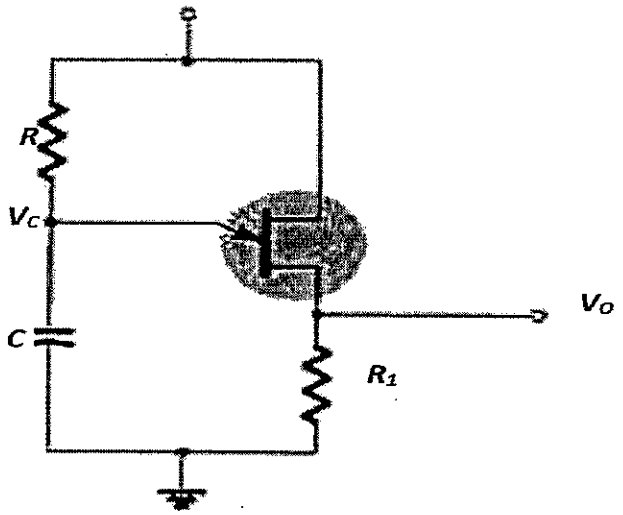

Figure-2Q(a)

i. Determine r_{B1} and r_{B2} at $I_E = 0A$. [4 Marks]

ii. Calculate V_P, the necessary voltage to turn on the UJT. [4 Marks]

iii. Determine whether R is within the permissible range to ensure firing of the UJT(ON state). [4 Marks]

iv. Determine the frequency of oscillation if $r_{B1} = 100\Omega$ during the discharge phase. [5 Marks]

Continued ...

(b) For the SCR circuit shown in Figure-2Q(b) the time constant should fall in the range 1 ms – 20 ms and $C = 0.068\mu F$. Calculate the resistances of R_1 and R_2 to give the full firing range of SCR. [3 Marks]

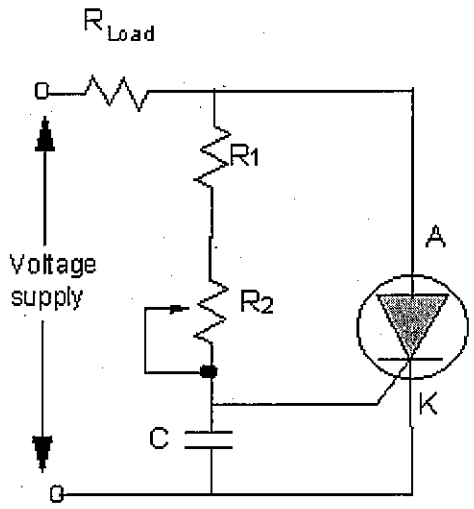

Figure -2Q(b)

Question 3 (20 Marks)

(a) A metal wire has a 2.5mm diameter and 2 m length. A force of 12N is applied to it and it stretches 0.3mm. Assume the material is elastic. Determine the following.

i. The stress in the wire(σ). [2 Marks]
ii. The strain in the wire (ϵ). [2 Marks]

Continued ...

(b) A resistor of 250Ω is connected in series with a second resistor of 750 Ω so that the 250 Ω resistor is connected to a supply of 12 Volts and the 750 Ω resistor is connected to ground (0V) as shown in the Figure-Q(3b). Calculate the following:

i. Total series resistance. [2 Marks]
ii. The current flowing through the series circuit. [2 Marks]
iii. Voltage drop across the 750 Ω resistor. [4 Marks]

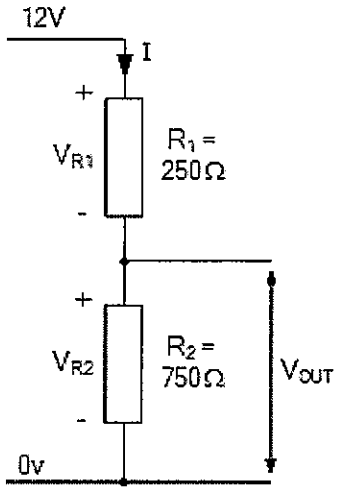

Figure-Q(3b)

(c) An RTD fabricated from platinum exhibits a temperature coefficient of resistivity $\alpha = 0.004/°C$. If the resistance of the sensor is 100Ω at $0°C$,

i. Find the resistance at $90°C$. [2 Marks]
ii. Determine the temperature rise when there is a current flow of $4mA$ through the sensor with $R_T = 200\Omega$. The self-heating factor is $F_{SH} = 8°C/mW$. [4 Marks]
iii. Determine the new values of temperature measurements that will be indicated by the RTD. [2 Marks]

Continued ...

Question 4(20 Marks)

(a) An optical shaft-encoder has a 16:2 gear ratio, an optical disc with 90 slits and a 9-bit binary counter.

i. How much movement of the measured shaft is required to increment the counter by 1 bit? [4 Marks]

ii. If the measured shaft moves 180° from its prior position (0°), what is the content of the binary counter? [3 Marks]

iii. What is the maximum allowable shaft motion to ensure that the counter never exceed its capacity? [4 Marks]

iv. What amount of shaft movement is represented by a binary output of 0101 1011 0? [2 Marks]

(b)

The optical shaft-encoder in Question Q4(a) has a direction-indicating ability. Its output is a 9-bit signed magnitude binary, with the 9^{th} bit Most Significant Bit (MSB) representing either sign bit 0 for positive (disc rotating clockwise), or 1 for negative (disc rotating counterclockwise).

i. What is the maximum allowable shaft movement to ensure that the counter never exceed its capacity? [3 Marks]

ii. What is the magnitude and direction of the measured shaft movement for a binary output of 001101111? [2 Marks]

iii. What is the magnitude and direction of the measured shaft movement for a binary output of 101010111? [2 Marks]

Continued ...

Question 5

(a) Suppose that a shunt-configured DC motor has an armature winding resistance $R_A = 3\Omega$, an applied voltage $V_A = 220V$, a field winding resistance $R_F = 150\Omega$, an armature current $I_A = 1.3A$, a rotational speed S = 2990 r/min, a magnetic field strength $B = 0.96T$ and $k_t = 0.7$.

i. Find the motor's proportionality factor $k_{E_{C3}}$. [6 Marks]

ii. Calculate the motor's output torque τ and its mechanical power P_{mech}. [4 Marks]

(b) A series-connected DC motor has an armature resistance of 0.5Ω and field winding resistance of 1.5Ω. In driving a certain load at 1200 rpm, the current drawn by the motor is 20A from a voltage source of V_T = 220V. The rotational loss is 150W. Find the output power and efficiency. [10 Marks]

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